



OPEN ACCESS

EDITED BY

Orna Heaysman,
Achva Academic College, Israel

REVIEWED BY

Isaiah T. Awidi,
University of Southern Queensland, Australia
Samuel Alejandro Portillo Peñuelas,
Instituto Tecnológico de Sonora (ITSON),
Mexico

*CORRESPONDENCE

Fabiola Sáez-Delgado
✉ fsaez@ucsc.cl

RECEIVED 14 July 2024

ACCEPTED 23 October 2024

PUBLISHED 19 November 2024

CITATION

López-Angulo Y, Sáez-Delgado F, Gaeta ML,
Mella-Norambuena J, González-Robaina Y and
Muñoz-Inostroza K (2024) Validation of the
self-regulation of learning instrument for
undergraduates.
Front. Educ. 9:1464424.
doi: 10.3389/educ.2024.1464424

COPYRIGHT

© 2024 López-Angulo, Sáez-Delgado, Gaeta,
Mella-Norambuena, González-Robaina and
Muñoz-Inostroza. This is an open-access
article distributed under the terms of the
[Creative Commons Attribution License
\(CC BY\)](https://creativecommons.org/licenses/by/4.0/). The use, distribution or reproduction
in other forums is permitted, provided the
original author(s) and the copyright owner(s)
are credited and that the original publication
in this journal is cited, in accordance with
accepted academic practice. No use,
distribution or reproduction is permitted
which does not comply with these terms.

Validation of the self-regulation of learning instrument for undergraduates

Yaranay López-Angulo¹, Fabiola Sáez-Delgado^{2*},
Martha Leticia Gaeta³, Javier Mella-Norambuena⁴,
Yaynel González-Robaina⁵ and Karla Muñoz-Inostroza¹

¹Departamento de Psicología, Facultad de Ciencias Sociales, Universidad de Concepción, Concepción, Chile, ²Departamento Fundamentos de la Pedagogía, Facultad de Educación, Centro de Investigación en Educación y Desarrollo (CIEDE-UCSC), Universidad Católica de la Santísima Concepción, Concepción, Chile, ³Facultad de Educación, Universidad Popular Autónoma del Estado de Puebla, Puebla, Mexico, ⁴Facultad de Salud y Ciencias Sociales, Universidad de Las Américas, Concepción, Chile, ⁵Facultad de Humanidades y Arte, Universidad de Concepción, Concepción, Chile

Introduction: Self-regulation of learning is an essential variable in university students' educational process and integral development, especially in the first semesters. Given its relevance, significant, valid, and reliable instruments are required for its measurement. Therefore, this study aimed to determine the psychometric properties of the SRLI-U scale that assesses Self-Regulation of Learning in Undergraduates.

Methods: An instrumental design was used, and the questionnaire was administered to 348 Chilean first-year university students (60.1% female) aged between 18 and 21 years ($M = 18.85$; $SD = 0.773$).

Results: Adequate adjustment indexes of the second order model were evidenced considering three dimensions theoretically coherent with Zimmerman's model (1) Learning Disposition, $\Omega = 0.861$, (2) Learning Performance, $\Omega = 0.842$, and (3) Learning Self-evaluation, $\Omega = 0.887$; and a general factor $\Omega = 0.936$.

Conclusion: It is a valid and reliable instrument for evaluating levels of self-regulation in Chilean university students.

Discussion: The SRLI-U constitutes a valuable tool for educational practice because it allows for evaluating, monitoring, and intervening the self-regulation of learning levels. Theoretical and practical implications are discussed, as well as the study's limitations.

KEYWORDS

self-regulation of learning, higher education, university students, questionnaire, psychometrics, SRL, validation

1 Introduction

Self-regulation of learning (SRL) is a fundamental aspect of the educational process, especially in the university context and during the first semesters (Pérez et al., 2021). Indeed, at this educational level, students face a more demanding and broader curriculum, challenging teaching styles and evaluations, compared to their experience at the previous academic level (middle school). Hence, at this stage, learning difficulties increase. However, when students are self-regulated, they can adapt more quickly to these changing demands (Sáez-Delgado et al., 2023). Thus, students' displayed capacity to manage their learning processes is crucial

for academic success, long-term skill development, and career retention (López-Angulo et al., 2023).

The importance of SRL is based on the following aspects: (a) Increased academic performance, as the evidence available at different academic levels solidly demonstrates that those students who possess self-regulation skills achieve optimal or outstanding performances; (b) Adaptability and flexibility, given that SRL implies adjusting strategies according to specific needs and challenges; (c) Development of metacognitive skills, since SRL involves reflection on the learning process itself, where students have to evaluate their understanding, identify areas for improvement and adjust their approach to achieve effective learning; (d) Reduction of anxiety, since the ability to self-regulate allows students to manage anxiety related to exams, deadlines and academic tasks because they have goals and a clear study strategy, which makes them feel more confident and prepared; (e) Promotion of autonomy, this is because SRL empowers students by making them active agents of their own learning process instead of relying exclusively on the teacher's instruction, where they are able to make informed and autonomous decisions; and (f) Ability transfer, it can be stated that self-regulation skills not only benefit the academic setting, but also apply to everyday life and/or future professional careers, i.e., students who learn to self-regulate are better prepared to face challenges in any context (Dent and Koenka, 2016; López-Angulo et al., 2022; Sáez-Delgado et al., 2018). In summary, SRL is an essential component for the comprehensive development of university students.

Self-regulated students are characterized by their ability to initiate cognitive, metacognitive, affective, and motivational processes. They can set their objectives, establish clear goals, plan their work, and monitor their progress by reflecting on their learning. Self-regulating their process allows them to optimize their time and effort, which translates into greater probabilities of success (Wong et al., 2019). In contrast, students with limited application of SRL strategies in their formative instances do not obtain good results (Psathas et al., 2023; Sáez-Delgado et al., 2021, 2023) and may present a risk of dropout (López-Angulo et al., 2023). Therefore, fostering these skills contributes significantly to their academic success and personal and professional growth.

1.1 Self-regulation of learning theoretical models

There are different SRL models available in the literature to define this construct and its components (for an in-depth review of each model, it is suggested to consult the works of Panadero, 2017; Puustinen and Pulkkinen, 2001). However, all of them agree that the student is the primary agent of his/her learning, has the responsibility, and can learn in interaction with the context. The present study is based on Zimmerman's theoretical model (Zimmerman, 2000), chosen mainly for its outstanding recognition at the international level (Wong et al., 2019) and for its ease of operationalization. This approach considers SRL as a competence developed through different tasks and environments.

The model proposed by Zimmerman (2000) considers a socio-cognitive perspective and emphasizes on strategies with complex and dynamic interactions influencing the students' engagement and effort toward optimal learning and performance, which are enhanced in highly autonomous learning environments. This author described SRL

processes as triadic, referring to the dynamic influence of self-regulatory processes on environmental events, personal, behavioral factors. Thus, he distinguished three phases of self-regulation that function in a cyclical, interrelated, and recursive manner during the learning process: disposition, performance, and self-evaluation (Zimmerman, 2013).

In the first phase, disposition, self-regulated learners are expected to actively engage in task analysis processes (i.e., goal setting and planning, designing a strategy for their learning). Then, the performance phase is activated when learners employ strategies to process learning material, seek help when needed, manage their time, structure their environment, and control their learning processes, being able to implement self-monitoring (i.e., self-instructions, focusing attention) and self-observation (i.e., self-registration and self-experimentation) strategies. Finally, the third phase self-evaluation occurs when students must assess their performance and adjust their strategies to achieve their learning objectives, i.e., self-judgment (self-evaluation of their learning process and causal attributions, and adaptation or defense) occurs in the final phase. These three phases repeat cyclically and iteratively throughout the learning process (Zimmerman, 2000). This description highlights that SRL is a multidimensional, complex, and recursive phenomenon that involves a set of cognitive, social, metacognitive, and behavioral processes whose interlocking is articulated in a cyclical model (Sáez-Delgado et al., 2022, 2023).

The ability of students to regulate their learning process is related to their commitment and achievement of personal learning objectives (Moreno-Marcos et al., 2020). However, one of the highly documented problems in education is that students often exhibit suboptimal levels of SRL at different levels of their academic trajectory (Sáez-Delgado et al., 2023), which in higher education makes them more likely to drop out of their programs of study (López-Angulo et al., 2023). Therefore, to describe, analyze and intervene in the promotion of this process, it is necessary to have a relevant and valid instrument.

Regarding the above, self-report measures constitute one of the primary methods for assessing SRL due to their relative ease of administration and scoring. However, psychometric properties are a fundamental need when assessing the quality of such measurement protocols (Roth et al., 2016).

1.2 Instruments for measuring self-regulation of learning in university students

A systematic literature review characterized various measurement instruments on SRL designed for students at different educational levels (León-Ron et al., 2020). The findings showed 31 instruments available, of which 57.5% correspond to instruments developed, adapted and validated in Higher Education. About the countries where these psychometric studies have been conducted, 24 countries were identified; however, it is in Europe where more psychometric studies on SRL were developed (40%); on the contrary, Central and South America and Oceania represented the lowest percentage (10 and 3%, respectively). This gap has been documented in other research, which indicates that Latin America is in the preliminary stage of developing of instruments to measure SRL and that further studies are required (López-Angulo et al., 2020).

An analysis of the instruments developed to measure SRL in university students allowed the authors of the present study to make a classification. Firstly, some instruments measure specific skills and strategies for learning, for example, a second language. Secondly, instruments focused on specific contexts, such as professions or online teaching modalities. Other instruments have been developed based on theoretical models other than Zimmerman's. Finally, there are instruments developed based on Zimmerman's theoretical model. In the following sections, we will analyze each category in detail.

Among the instruments that aim to know how students use specific SRL skills and strategies to learn a second language, an item example is: *For me, successful learning of English is more important than my grades or opinion of my teachers, family, or Friends* (e.g., Salehi and Jafari, 2015; Teng and Zhang, 2016). Other instruments along the same lines are those focused on assessing the use of SRL in specific skills, such as writing. An item example is: *When writing, I use some literary devices to make the composition more interesting* (e.g., Teng and Zhang, 2016). For reading comprehension, an item example is: *From that first glance, I question myself to the point of clarifying what I know about the subject* (e.g., Solano-Pizarro et al., 2004). In these cases, the content of the items covers aspects of language learning and writing. Thus, the items not only assess the process of self-regulation but also reflect the context in which they are being assessed.

Other instruments focus on specific contexts, either linked to a specific profession, career, or course modality (e.g., Iyama and Maeda, 2018). An item example is: *Using my own words, I want to explain important points I have learned in my clinical nursing practice*. A significant limitation is that the scale is titled "Development of the Self-Regulated Learning Scale in Clinical Nursing Practice for nursing students," and it is composed of only two subscales, one for motivation and one for learning strategies. Another instrument of this group is that of Barnard et al. (2010), which evaluates learning in online courses. An item example is: *I set standards for my assignments in online courses* (Barnard et al., 2010).

There are also instruments developed with theoretical models other than Zimmerman (2000), such as the Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich et al., 1993), which is based on Pintrich (2000) model and comprises two dimensions: Motivation and Learning Strategies.

Of the questionnaires that were developed based on Zimmerman's theoretical model, the Academic Self-Regulated Learning Scale (A-SRL-S) (Magno, 2010) is composed of seven factors: memory strategy, goal setting, self-evaluation, help seeking, structuring the environment, responsibility for learning, and planning and organization. Similarly, the Learning and Study Strategies Inventory (LASSI) (Weinstein and Palmer, 2002) covers three dimensions: ability, disposition, and self-regulation. Although both instruments explicitly measure SRL, they do not exhaustively evaluate the aspects contained in Zimmerman's model. Also, there is the Inventory of Self-Regulation of Learning Processes (IPAA) (Rosário et al., 2007), has a significant limitation: the items that make up the scale are not univocal, some items evaluate two actions in one sentence, which can cause confusion. Therefore, the items must be specific and capable of capturing the abstract construct they intend to measure to guarantee the validity of the scales (Löhr, 2022; Diamantopoulos et al., 2012; Lilienfeld and Strother, 2020; Tavakol and Wetzal, 2020). Conversely, it may have significant consequences in the measurement error of latent variables (Rhemtulla et al., 2020).

A scale that overcomes these limitations and is based on Zimmerman's theoretical model is the Instrument to Measure Self-Regulation of Learning Phases (Sáez-Delgado et al., 2022), which was designed to measure the three phases of the SRL process (disposition, performance and evaluation) in Chilean secondary students. This scale has several advantages: (1) It considers the different dimensions (behavioral, motivational and cognitive) that are part of the study and learning processes of students (Roth et al., 2016); (2) It is based on Zimmerman (2000) theoretical model of SRL phases; (3) It showed good adjustment indexes in the original study; and (4) It allows identifying those variables with inadequate levels. Therefore, it is presented as an alternative and valuable scale to measure SRL in university students.

1.3 The present study: gap and research questions

Despite the relevance of the SRL, to our knowledge, there are no validations of the Instrument to Measure Self-Regulation of Learning Phases (Sáez-Delgado et al., 2022) in university students. Therefore, the general objective of this research was to validate and estimate the psychometric properties of an instrument to measure the phases of self-regulation of learning in Chilean university students. Specifically, we sought answers to the following questions:

- QR1: What is the factorial structure of the Instrument for Measuring the Self-Regulation of Learning Phases in Chilean university students?
- QR2: What are the discriminant validity indices of the Instrument for Measuring the Self-Regulation of Learning Phases in Chilean university students?
- QR3: What are the reliability indices of the Instrument for Measuring the Self-Regulation of Learning Phases of in Chilean university students?

2 Methods

2.1 Design

An instrumental design was used to carry out the study, which according to the classification of Ato et al. (2013), it considers the psychometric characteristics analysis of the Instrument to Measure Self-Regulation of Learning Phases (Sáez-Delgado et al., 2022) in a sample of Chileans university students.

2.2 Participants

Participants comprised 348 first-year university students from STEMS careers university in southern Chile participated. Of the total 136 were men (39.1%), 209 women (60.1%), and 3 preferred not to say (0.9%). Their ages ranged from 18 to 21 years ($M = 18.85$; $SD = 0.773$). Non-probability convenience sampling was used, considering the cohort of first-year students.

2.3 Instruments

Scale to measure self-regulation of learning phases (Sáez-Delgado et al., 2022): is composed of three subscales that account for the process of self-regulation of learning in consonance with the cyclical model proposed by Zimmerman (2000). It is a self-report instrument with a 7-point Likert scale, ranging from 1 meaning never to 7 meaning always. The validation with high school students showed adequate psychometric properties, with a structure composed of three factors. The first scale, before studying (Learning Disposition Phase), is composed of 5 items that measure the frequency with which students use self-regulation strategies to prepare for their study, e.g., “Before starting to study, I set short-term academic goals (daily, weekly),” and reliability was adequate ($\alpha > 0.79$; $\Omega > 0.82$). The second scale, while studying (Learning Performance Phase) is composed of 6 items and measures the frequency with which students use strategies to control their study based on a previously established planning that includes the goals to be achieved, e.g., “While studying, I check if I am learning,” and the reliability was adequate ($\alpha > 0.87$; $\Omega > 0.91$). The third scale, after studying (Learning Self-evaluation Phase), is composed of 5 items and measures the frequency with which students reflect on the results obtained in some school task or test, e.g., “When I finish studying, I self-evaluate whether I made progress in relation to my previous knowledge,” and reliability was adequate ($\alpha > 0.85$; $\Omega > 0.87$). The items’ average represents the score for each scale. Frequency values for using self-regulation strategies indicate: (a) Learners at optimal SRL levels (6–7 points), (b) Learners at suboptimal SRL levels (3–5), (c) Learners at insufficient SRL levels (1–2).

Meaning in life questionnaire (Steger et al., 2006): consists of 10 items designed to assess the meaning of life. This instrument was translated into Spanish through translation and back-translation, thus ensuring its linguistic equivalence. The questionnaire is composed of two subscales: “Presence of Meaning,” which includes items 1, 4, 5, 6, and 9; and “Search for Meaning,” which comprises items 2, 3, 7, 8, and 10. The answers in the questionnaire are given through a Likert-type scale, ranging from 1 (totally false) to 7 (totally true).

Additionally, sociodemographic data was collected, including sex, age, career, and other data relevant to the study.

2.4 Procedure

Data collection was carried out as part of a larger research project. The project coordinators established contact with the academic authorities to whom the purpose of the study was explained. After obtaining their authorization, dates for administering the questionnaires were agreed upon. The surveyors entered the classrooms, offered students the opportunity to participate after explaining the objectives of the research. Those students who agreed to participate signed an informed consent form before completing the questionnaire. The Ethics Committee CEBB1394-2023 approved this research.

2.5 Data analysis

First, descriptive analyses of the items that make up the instrument were performed to evaluate their distribution using

descriptive statistics, together with skewness and kurtosis coefficients. To examine the factorial structure, a Confirmatory Factor Analysis (CFA) was implemented to evaluate its underlying structure and compare its settings (Bollen, 1989). The Robust Maximum Likelihood Estimation (MLR) method was used, which does not require normality of the data due to its robustness in identifying significant effects (Lloret-Segura et al., 2014). The analysis was carried out with MPlus 8.4 software, evaluating the model fit using several indices: a non-significant Chi-square value ($p \geq 0.05$) (Tabachnik and Fidell, 2007), a Root mean square error of approximation (RMSEA) and Standardized root mean square residual (SRMR) below 0.07, and a 90% confidence interval (CI) between 0.000–0.050 (Hu and Bentler, 1999; Steiger, 2007), and Comparative fit index (CFI) and Tucker-Lewis Index (TLI) values above 0.94, in addition to requiring that the factor loadings of the items be significant and above the threshold of 0.40 (Hair et al., 2014). Correlations between dimensions and items were also performed to deepen the analysis. In addition, as part of the construct validation, discriminant validity analyses were performed, implying that two theoretically unrelated variables reflected on low or non-existent correlations. In this research, which explores validity based on discriminant measures, correlations of magnitude < 0.50 indicate that the instruments assess different constructs. Validity was estimated with the Meaning in Life Questionnaire (Steger et al., 2006). Reliability was calculated using McDonald (1978) Omega coefficient (Ω), a measure considered more accurate than the alpha coefficient since it considers factor loadings rather than simply the number of items or response options (Hayes and Coutts, 2020), expecting to obtain values above 0.70. The JASP software version 0.8.3.1 was used for this calculation.

3 Results

Table 1 shows the descriptive statistics for the 16 items of the instrument. The scores for all items were slightly higher than the scale’s midpoint. The analysis of skewness and kurtosis presented values according to expectations, so a normal distribution is assumed (Hatem et al., 2022).

3.1 QR1: analysis of the factorial structure

Exploratory CFAs were performed to evaluate the factorial structure of the instrument form measuring the self-regulation of learning phases since these analyses allow the modeling of different factorial solutions (Bollen, 1989; Schmitt, 2011). Table 2 presents the fit results obtained for the different models tested.

First, a CFA was performed considering the three subscales suggested by the creators of the instrument (Sáez-Delgado et al., 2022); as can be seen, only subscale 2 had adequate fit indices, so it was decided to test a solution of three first-order related factors. However, it did not fit as expected.

Given this scenario, it was decided to respecify the model, considering the trajectories indicated by the Mplus through the analysis of the modification indexes. The relationships were only added considering their theoretical sense; since this instrument

TABLE 1 Descriptive statistics of the SRLI-U items.

Items	Mean	Standard deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Error	Statistic	Error
1	4.97	1.536	-0.715	0.131	0.061	0.261
2	5.16	1.396	-0.770	0.131	0.408	0.261
3	4.45	1.789	-0.310	0.131	-0.879	0.261
4	5.50	1.469	-1.253	0.131	1.332	0.261
5	5.15	1.561	-0.875	0.131	0.282	0.261
6	5.05	1.538	-0.780	0.131	0.062	0.261
7	5.32	1.275	-0.759	0.131	0.407	0.261
8	5.07	1.466	-0.808	0.131	0.286	0.261
9	5.39	1.346	-1.074	0.131	1.076	0.261
10	5.43	1.516	-1.175	0.131	0.914	0.261
11	5.28	1.293	-0.804	0.131	0.697	0.261
12	5.10	1.478	-0.793	0.131	0.363	0.261
13	5.12	1.499	-0.749	0.131	0.094	0.261
14	4.84	1.734	-0.628	0.131	-0.438	0.261
15	5.11	1.525	-0.769	0.131	0.085	0.261
16	4.86	1.708	-0.664	0.131	-0.369	0.261

TABLE 2 Estimates of the analyzed models.

Model	χ^2	Df	RMSEA	(90% CI)	SRMR	CFI	TLI
Learning Disposition Phase	28.042*	5	0.115	0.076–0.158	0.036	0.943	0.886
Learning Performance Phase	13.115*	9	0.036	0.000–0.076	0.022	0.992	0.986
Learning Self-evaluation Phase	30.638*	5	0.121	0.082–0.164	0.040	0.930	0.861
Three related first-order factors	404.433*	101	0.093	0.084–0.103	0.059	0.860	0.833
One second-order factor and three first-order factors	404.433*	101	0.093	0.084–0.103	0.059	0.860	0.833
One second-order factor and three first-order factors with modification indexes	234.222*	97	0.064	0.053–0.074	0.045	0.937	0.923

* $p < 0.05$.

accounts for a theoretical model of three related and sequential phases, items sharing similar contents, although belonging to different factors, tended to show linked residuals. In this case, the residuals of items 10 and 4 (MI = 69.347), 13 and 12 (MI = 45.193), 16 and 3 (MI = 27.149), and 14 and 10 (MI = 22.738) were correlated. These pairs of items allude in their wording to the conditions of the place chosen to study, self-evaluation of the fulfillment of study goals, elaboration of a schedule to organize study time, and conditions of the place chosen to study, respectively. Thus, a better fit was obtained in the model. As shown in Table 2, the last solution

is the one that presented the best fit and is consistent with the theoretical approach of (Zimmerman, 2000), a structure of one second-order factor and three first-order factors is confirmed.

Table 3 reports the factor loadings obtained for the three factors proposed for the analysis, all of which presented significant loadings in the second order factor. All items had loadings above 0.40; this reflects adequate levels of association in all items of the instrument with respect to the dimensions, thus confirming three dimensions: (1) Learning Disposition, (2) Learning Performance and (3) Learning Self-evaluation (see Table 3).

TABLE 3 Factor loadings for the SRLI-U.

Items	F1	F2	F3
1	0.752**		
2	0.823**		
3	0.703**		
4	0.672**		
5	0.699**		
6		0.677**	
7		0.748**	
8		0.810**	
9		0.817**	
10		0.692**	
11		0.860**	
12			0.752**
13			0.788**
14			0.737**
15			0.854**
16			0.699**

** $p < 0.01$.

TABLE 4 Item-dimension correlations.

Items	F1	F2	F3
1	0.811**		
2	0.824**		
3	0.838**		
4	0.728**		
5	0.780**		
6		0.756**	
7		0.809**	
8		0.864**	
9		0.823**	
10		0.756**	
11		0.860**	
12			0.798**
13			0.831**
14			0.815**
15			0.844**
16			0.790**

** $p < 0.01$.

As for the correlations of the instrument items, Table 4 shows that all items correlated significantly with the dimension to which they correspond, reflecting adequate levels of association in all instrument items concerning their dimensions.

Considering this confirmed structure, it is different from what the authors proposed in the original version of the instrument (Sáez-Delgado et al., 2022), presenting a structure composed of three interrelated dimensions, which in turn forms a global construct that

accounts for the process of self-regulation of learning, its cyclicity, and functioning by phases (Figure 1).

This confirms a second-order factorial model composed of 16 items, where factor 1 (learning disposition) measures aspects related to the self-regulation strategies used by students to prepare their study, for example, setting academic goals, preparing materials, making a schedule, defining a suitable place and prioritizing a to-do list; factor 2 (learning performance) refers to the self-regulatory learning strategies that students use to monitor their study based on the previously established planning that includes self-monitoring while studying, i.e., checking if the time is sufficient, if the learning strategies they are using are effective, if the materials are sufficient, if the place is adequate, if they are meeting or not meeting the study goals, and checking if they are learning; factor 3 (learning self-evaluation) captures the self-regulation strategies of learning that students use to verify and self-evaluate the effectiveness of the study planning executed, i.e., self-evaluate if they made progress with respect to previous knowledge, if they met the goals they set, if the place was adequate, if the learning strategies were effective, and if they met the schedule. These factors make up a general factor, which based on the theoretical meaning of the items, will be called Phases of Self-Regulation of Learning, see Annex 1.

3.2 QR2: analysis of discriminant validity indices

With the Meaning in Life scale (Steger et al., 2006), validity based on divergent measures was explored. The results in the table indicated the existence of significant correlations between the factors of the instruments, with a range from $r = 0.303$ to $r = 0.359$; despite this, it has a low magnitude (Table 5). These findings suggest that both instruments are assessing different constructs.

3.3 QR3: analysis of reliability indices

As shown in Table 6, each dimension of the scale has adequate indices, being higher than 0.70 and lower than 0.93. These coefficients suggest that the dimensions and the instrument are reliable for measuring the phases of self-regulation of learning in Chilean university students.

4 Discussion

This research aimed to validate and estimate the psychometric properties of the Self-Regulation of Learning Instrument for Undergraduates (SRLI-U), which arose from the need for a valid and reliable instrument with these characteristics in Chilean university students. The main results are discussed below, along with the conclusions, limitations and future lines of research.

The results confirm the instrument's validity and reliability and the SRL's phased functioning. However, unlike its original version with Chilean high school students, the questionnaire presents a structure of three interrelated dimensions (learning disposition, learning performance and learning self-evaluation) that integrate a global construct on SRL. It is inferred that this difference between both scales

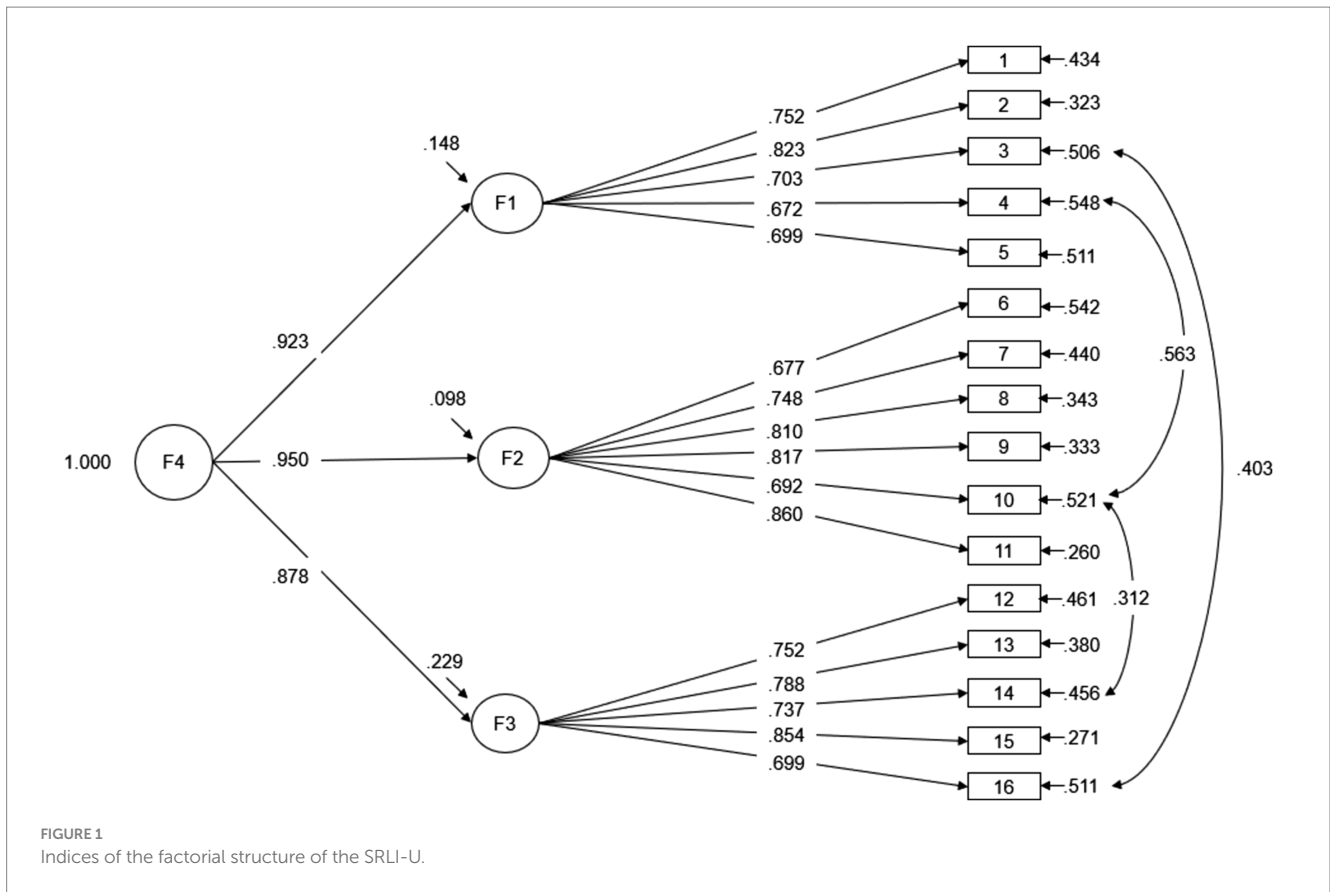


TABLE 5 Correlations between variables.

Variables	1	2	3	4	5
(1) Learning disposition	1.000				
(2) Learning performance	0.747**	1.000			
(3) Learning self-evaluation	0.679**	0.749**	1.000		
(4) Presence of meaning	0.359**	0.358**	0.338**	1.000	
(5) Search for meaning	0.303**	0.303**	0.318**	0.303**	1.000

** $p < 0.01$.

is due to a greater metacognitive capacity of university students compared to high school students since these skills are developed over time in interaction with the context (Panadero, 2017; Puustinen and Pulkkinen, 2001), which is why in this study a global construct of SRL is presented.

The results showed that the subdimensions were consistent with the underlying theoretical model developed by Zimmerman (2000). From the socio-cognitive perspective (Zimmerman, 2000), the instrument “Phases of Self-Regulation of Learning” corroborates that the development of SRL constitutes a dynamic process where, once students establish goals for their learning, they seek to monitor and regulate such processes for their achievement, which involves both personal and environmental factors. In this respect, evidence shows that SRL evolves over time (Higgins et al., 2021). Therefore, the student becomes an active agent in his/her learning process. This last aspect is relevant considering that, in their first university years,

students face academic, social, and emotional challenges and demands (López-Angulo et al., 2021). To address these challenges, they must learn to implement metacognitive and self-regulatory learning strategies (Tinto, 2010; López-Angulo et al., 2024).

Regarding divergent validity, the results showed significant but low correlations between the SRL scales and the Meaning in Life Questionnaire. These findings suggest that both instruments assess different constructs (Fornell and Larcker, 1981). This distinction is crucial because it emphasizes the independence of the measured constructs and demonstrates that a high level of SRL does not necessarily imply a search for meaning in life. The literature supports this separation, indicating that self-regulation focuses more on learning processes, whereas meaning in life addresses existential and personal aspects. These findings have important practical implications, indicating the need to select the appropriate instrument according to the measurement objective.

TABLE 6 Internal consistency coefficients.

Factors	Items	Cronbach's alpha	McDonald's omega
F1	1, 2, 3, 4, 5	0.860	0.861
F2	6, 7, 8, 9, 10, 11	0.817	0.842
F3	12, 13, 14, 15, 16	0.886	0.887
General factor		0.933	0.936

Regarding reliability, the indices obtained in this study indicate that the instrument presents acceptable psychometric properties, with values above 0.70, a commonly accepted standard in psychological and educational research (Streiner et al., 2024). This reliability is crucial to ensure that the instrument can consistently identify SRL processes in Chilean university students. Additionally, it is important to consider the impact of the cultural and educational context on the reliability of the instrument. Differences in the interpretation of the items among different groups may influence the results, suggesting the need for future research to evaluate the instrument's stability in different contexts. The above allows proposing an instrument with acceptable psychometric properties to identify these processes in Chilean university students.

4.1 Applicability and utility

This study has important theoretical and practical implications. From the theoretical edge, it contributes to the advancement in psychometric research on measuring SRL, overcoming limitations of previous studies that have shown low rigor in the content validation of their instruments (López-Angulo et al., 2020). Additionally, it contributes to a theoretical gap regarding the development of validated questionnaires in Latin America (Hernández et al., 2017; León-Ron et al., 2020; López-Angulo et al., 2020).

From the practical perspective, a valid and reliable instrument to measure SRL in university students is of utmost relevance, demonstrating practical applications beyond the research. Specifically: (a) It allows an accurate assessment of the student's self-regulatory skills, facilitating an in-depth understanding of how they manage their learning process; (b) It facilitates the design of educational interventions, especially when a group of students with difficulties in their phases of the self-regulatory process is identified while applying the instrument, allowing to visualize in which of them to emphasize for their promotion and development. Based on this, specific strategies can be developed to improve these skills (Sáez-Delgado et al., 2018); (c) Progress Monitoring, having a valid and reliable instrument allows monitoring the progress of the student body over time, thus observing whether their self-regulatory skills improve, remain stable or require attention (Mella-Norambuena et al., 2021); (d) Identification of Individual Needs, this is especially relevant, as each student is unique in how they self-regulate, which guides the adaptation of teaching strategies accordingly for the faculty (Contreras-Saavedra et al., 2024); (e) Improvement of teaching practice, making available an SRL phasing instrument available allows teachers to assess and understand their students' self-regulatory skills, helping them to adapt their pedagogical approach and offer specific support when needed (De La Fuente et al., 2020; López-Angulo et al., 2022).

In summary, this study provides an adequately validated instrument to measure SRL becoming a valuable tool for research and educational practice. It thus contributes to the comprehensive development of students and their academic success.

4.2 Limitations and future research

The obtained results provide valuable information on the validity and reliability of the SRLI-U. However, it is important to consider some limitations and areas for future research. A relevant element that must necessarily be mentioned is the type of instrument that was validated in this study, which is a self-report. Considering that it was applied to university students, it is likely to present, to some extent, the so-called social desirability bias in the process of collecting the responses obtained (Durmaz et al., 2020; Fisher and Katz, 2000). Specifically, this implies questioning the scores obtained by the scale that could obtain a high average in the different phases of the SRL process. Now, while there are other alternatives for measuring SRL in college students, for example, observational instruments, measurements through the learning analytics approach, and more recently with measurement challenges based on artificial intelligence (Molenaar et al., 2023), possible difficulties or limitations are identified with these instruments. Therefore, the recommendation is that future research that seeks to measure SRL in university students should consider integrating more than one measure method to achieve a more accurate understanding of this phenomenon.

5 Conclusion

In conclusion, this study represents a significant advance in research on self-regulation of learning (SRL) by providing a validated and reliable instrument that measures the SRL phases in Chilean university students. The results confirm that the scale presents a robust factorial structure with three interrelated dimensions: Learning disposition, learning performance, and learning self-evaluation.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Ethics, Bioethics, and Biosafety Committee, Vice-Rectorate for Research and Development (VRID), Universidad de Concepción. Ethics Committee approval number: CEBB1394-2023. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

YL-A: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration,

Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. FS-D: Conceptualization, Methodology, Supervision, Writing – review & editing. MG: Supervision, Writing – review & editing. JM-N: Data curation, Formal analysis, Software, Supervision, Validation, Writing – review & editing. YG-R: Supervision, Visualization, Writing – review & editing. KM-I: Conceptualization, Visualization, Writing – review & editing.

acknowledge the use of GPT-4 to improve the wording of some parts of the manuscript.

Funding

The author(s) declare that financial support was received for the research, authorship, and/or publication of this article. This study was funded by the FONDECYT Initiation Project N°11230864 entitled “Academic and life purposes, social adaptation, emotional, motivational, and academic self-regulation: A mixed design to explain dropout intention and university academic performance” of the National Research and Development Agency of Chile (ANID) assigned to YL-A; and Project C23-025: “Counseling guide to promote self-regulated learning”. Teaching Support Fund 2023 Collaborate.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

Acknowledgments

The authors are grateful to the students from the universities of the Biobio region who participated in this study. We gratefully

Supplementary material

The Supplementary material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/feduc.2024.1464424/full#supplementary-material>

References

- Ato, M., López, J. J., and Benavente, A. (2013). Un sistema de clasificación de los diseños de investigación en psicología. *Anales Psicol.* 29, 1038–1059. doi: 10.6018/analesps.29.3.178511
- Barnard, L., Paton, V. O., and Lan, W. Y. (2010). Profiles in self-regulated learning in the online learning environment. *Int. Rev. Res. Open Distrib. Learning* 11, 61–80. doi: 10.19173/irrodl.v11i1.769
- Bollen, K. A. (1989). *Structural equations with latent variables*. Amsterdam: Wiley.
- Contreras-Saavedra, C., Sáez-Delgado, F., Manriquez, C., López-Angulo, Y., and Mella-Norambuena, J. (2024). Procesos autor regulatorios en profesorado de secundaria durante las clases online por COVID-19. *Zona Próxima* 41, 89–109. doi: 10.14482/zp.41.456.654
- De La Fuente, J., Peralta-Sánchez, F. J., Martínez-Vicente, J. M., Sander, P., Garzón-Umerenkova, A., and Zapata, L. (2020). Effects of self-regulation vs external regulation on the factors and symptoms of academic stress in undergraduate students. *Front. Psychol.* 11:1773. doi: 10.3389/fpsyg.2020.01773
- Dent, A. L., and Koenka, A. C. (2016). The relation between self-regulated learning and academic achievement across childhood and adolescence: a meta-analysis. *Educ. Psychol. Rev.* 28, 425–474. doi: 10.1007/s10648-015-9320-8
- Diamantopoulos, A., Sarstedt, M., Fuchs, C., Wilczynski, P., and Kaiser, S. (2012). Guidelines for choosing between multi-item and single-item scales for construct measurement: a predictive validity perspective. *J. Acad. Mark. Sci.* 40, 434–449. doi: 10.1007/s11747-011-0300-3
- Durmaz, A., Dursun, I., and Kabaday, E. (2020). “Mitigating the effects of social desirability Bias in self-report surveys: classical and new techniques” in *Applied social science approaches to mixed methods research*. eds. M. L. Baran and J. E. Jones (Hershey, PA: IGI Global), 146–185.
- Fisher, R. J., and Katz, J. E. (2000). Social-desirability bias and the validity of self-reported values. *Psychol. Mark.* 17, 105–120. doi: 10.1002/(SICI)1520-6793(200002)17:2<105::AID-MAR3>3.0.CO;2-9
- Fornell, C., and Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *J. Mark. Res.* 18, 39–50. doi: 10.1177/002224378101800104
- Hair, J. F., Black, W. C., Babin, B. J., and Anderson, R. E. (2014). *Multivariate Data Analysis*. London: Pearson New International Edition.
- Hatem, G., Zeidan, J., Goossens, M., and Moreira, C. (2022). Normality testing methods and the importance of skewness and kurtosis in statistical analysis. *BAU J. Sci. Technol.* 3:9512. doi: 10.54729/ktpe9512
- Hayes, A. F., and Coutts, J. J. (2020). Use omega rather than Cronbach's alpha for estimating reliability. But *Commun. Methods Meas.* 14, 1–24. doi: 10.1080/19312458.2020.1718629
- Hernández, A., and Camargo, Y. A. (2017). Autorregulación del Aprendizaje en la Educación Superior en Iberoamérica: una Revisión Sistemática. *Rev. Latinoamericana Psicol.* 49, 146–160. doi: 10.1016/j.rlp.2017.01.001
- Higgins, N., Rathner, J., and Frankland, S. (2021). Development of self-regulated learning: a longitudinal study on academic performance in undergraduate science. *Res. Sci. Technol. Educ.* 41, 1242–1266. doi: 10.1080/02635143.2021.1997978
- Hu, L., and Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. *Struct. Equ. Model. Multidiscip. J.* 6, 1–55. doi: 10.1080/10705519909540118
- Iyama, S., and Maeda, H. (2018). Development of the self-regulated learning scale in clinical nursing practice for nursing students: consideration of its reliability and validity. *Jpn. J. Nurs. Sci.* 15, 226–236. doi: 10.1111/jjns.12191
- León-Ron, V., Saez, F. M., Mella, J. A., Posso-Yépez, M., Ramos, C. A., and Lobos, K. A. (2020). Revisión sistemática sobre instrumentos de autorregulación del aprendizaje diseñados para estudiantes. *Rev. Espacios* 41:1–24.
- Lilienfeld, S. O., and Strother, A. N. (2020). Psychological measurement and the replication crisis: four sacred cows. *Can. Psychol.* 61, 281–288. doi: 10.1037/cap0000236
- Lloret-Segura, S., Ferreres-Traver, A., Hernández-Baeza, A., and Tomás-Marco, I. (2014). El análisis factorial exploratorio de los ítems: una guía práctica revisada y actualizada. *Anales Psicol.* 30, 1151–1169. doi: 10.6018/analesps.30.3.199361
- Löhr, G. (2022). What are abstract concepts? On lexical ambiguity and concreteness ratings. *Rev. Philos. Psychol.* 13, 549–566. doi: 10.1007/s13164-021-00542-9
- López-Angulo, Y., Cobo-Rendón, R., Sáez-Delgado, F., and Díaz-Mujica, A. (2021). Exploratory factor analysis of the student adaptation to college questionnaire short version in a sample of Chilean university students. *Univ. J. Educ. Res.* 9, 813–818. doi: 10.13189/ujer.2021.090414
- López-Angulo, Y., Sáez-Delgado, F., Arias-Roa, N., and Díaz-Mujica, A. (2020). Revisión sistemática sobre instrumentos de autorregulación del aprendizaje en estudiantes de educación secundaria. *Inform. Tecnol.* 31, 85–98. doi: 10.4067/S0718-07642020000400085
- López-Angulo, Y., Sáez-Delgado, F., and Mella-Norambuena, J. (2024). Propósitos de vida y académicos en estudiantes universitarios chilenos de carreras STEM (Ciencia, Tecnología, Ingeniería, y Matemáticas). *Form. Univ.* 17, 83–100. doi: 10.4067/s0718-50062024000200083

- López-Angulo, Y., Sáez-Delgado, F., Mella-Norambuena, J., Bernardo, A., and Díaz-Mujica, A. (2023). Predictive model of the dropout intention of Chilean university students. *Front. Psychol.* 13:893894. doi: 10.3389/fpsyg.2022.893894
- López-Angulo, Y., Sáez-Delgado, F., Torres, K., Vega, C., Fuentes, C., and García, T. (2022). Prácticas docentes de autorregulación del aprendizaje para la promoción de la permanencia universitaria en contexto de pandemia. *Revista E-Psi* 11, 141–156.
- Magno, C. (2010). Assessing academic self-regulated learning among Filipino college students: the factor structure and item fit. *Int. J. Educ. Psychol. Assessment* 5, 61–78.
- Mella-Norambuena, J., Cobo-Rendon, R., Lobos, K., Sáez-Delgado, F., and Maldonado-Trapp, A. (2021). Smartphone use among undergraduate STEM students during COVID-19: an opportunity for higher education? *Educ. Sci.* 11:417. doi: 10.3390/educsci11080417
- McDonald, R. P. (1978). Generalizability in Factorable Domains: "Domain Validity and Generalizability" *Educational and Psychological Measurement*, 38:75–79. doi: 10.1177/001316447803800111
- Molenaar, I., De Mooij, S., Azevedo, R., Bannert, M., Järvelä, S., and Gašević, D. (2023). Measuring self-regulated learning and the role of AI: five years of research using multimodal multichannel data. *Comput. Hum. Behav.* 139:107540. doi: 10.1016/j.chb.2022.107540
- Moreno-Marcos, P. M., Muñoz-Merino, P. J., Maldonado-Mahauad, J., Pérez-Sanagustín, M., Alario-Hoyos, C., and Kloos, C. D. (2020). Temporal analysis for dropout prediction using self-regulated learning strategies in self-paced MOOCs. *Comput. Educ.* 145:103728. doi: 10.1016/j.compedu.2019.103728
- Panadero, E. (2017). A review of self-regulated learning: six models and four directions for research. *Front. Psychol.* 8:422. doi: 10.3389/fpsyg.2017.00422
- Pérez, M. V., López-Angulo, Y., and Díaz-Mujica, A. (2021). Facilitación Intracurricular de la Autorregulación del Aprendizaje Universitario. Concepción: Universidad de Concepción.
- Pintrich, P. R. (2000). "Chapter 14- the role of goal orientation in self-regulated learning" in *Handbook of self-regulation*. eds. M. Boekaerts, P. R. Pintrich and M. Zeidner (New York, NY: Academic Press), 451–502.
- Pintrich, P., Smith, D. A. E., Garcia, T., and Mckeachie, W. J. (1993). Reliability and predictive validity of the motivated strategies for learning questionnaire (MSLQ). *Educ. Psychol. Meas.* 53, 801–813. doi: 10.1177/0013164493053003024
- Psathas, G., Chatzidakis, T. K., and Demetriadis, S. N. (2023). Predictive modeling of student dropout in MOOCs and self-regulated learning. *Computers* 12, 1–17. doi: 10.3390/computers12100194
- Puustinen, M., and Pulkkinen, L. (2001). Models of self-regulated learning: a review. *Scand. J. Educ. Res.* 45, 269–286. doi: 10.1080/00313830120074206
- Rhemtulla, M., Van Bork, R., and Borsboom, D. (2020). Worse than measurement error: consequences of inappropriate latent variable measurement models. *Psychol. Methods* 25, 30–45. doi: 10.1037/met0000220
- Rosário, P., Mourão, R., Núñez Pérez, J. C., González-Piendá García, J. A., Solano Pizarro, P., and Valle Arias, A. (2007). Eficacia de un programa instruccional para la mejora de procesos y estrategias de aprendizaje en la enseñanza superior. *Psicothema* 19, 422–427.
- Roth, A., Ogrin, S., and Schmitz, B. (2016). Assessing self-regulated learning in higher education: a systematic literature review of self-report instruments. *Educ. Assess. Eval. Account.* 28, 225–250. doi: 10.1007/s11092-015-9229-2
- Sáez-Delgado, F. M., Díaz, A. E., Panadero, E., and Bruna, D. V. (2018). Revisión sistemática sobre competencias de autorregulación del aprendizaje en estudiantes universitarios y programas intracurriculares para su promoción. *Form. Univ.* 11, 83–98. doi: 10.4067/S0718-50062018000600083
- Sáez-Delgado, F., López-Angulo, Y., Mella-Norambuena, J., Baeza-Sepúlveda, C., Contreras-Saavedra, C., and Lozano-Peña, G. (2022). Teacher self-regulation and its relationship with student self-regulation in secondary education. *Sustain. For.* 14:6863. doi: 10.3390/su142416863
- Sáez-Delgado, F., Mella-Norambuena, J., López Angulo, Y., Olea-González, C., García-Vásquez, H., and Porter, B. (2021). Association between self-regulation of learning, forced labor insertion, technological barriers, and dropout intention in Chile. *Front. Educ.* 6:801865. doi: 10.3389/feduc.2021.801865
- Sáez-Delgado, F., Mella-Norambuena, J., López-Angulo, Y., Sáez, Y., and León-Ron, V. (2023). Invariant and suboptimal trajectories of self-regulated learning during secondary school: implications focused on quality in higher education. *Front. Psychol.* 14:1235846. doi: 10.3389/fpsyg.2023.1235846
- Salehi, M., and Jafari, H. (2015). Development and validation of an EFL self-regulated learning questionnaire. *Southern Afr. Ling. Appl. Lang. Stu.* 33, 63–79. doi: 10.2989/16073614.2015.1023503
- Schmitt, T. (2011). Current methodological considerations in exploratory and confirmatory factor analysis. *J. Psychoeduc. Assess.* 29, 304–321. doi: 10.1177/0734282911406653
- Solano-Pizarro, P., González-Piendá, J., González-Pumariega Solis, S., and Núñez, J. (2004). Autorregulación del aprendizaje a partir de textos. *Rev. Galego-Portuguesa Psicología E Educ.* 11, 1138–1663.
- Steger, M., Frazier, P., Oishi, S., and Kaler, M. (2006). The meaning in life questionnaire: assessing the presence of and search for meaning in life. *J. Couns. Psychol.* 53, 80–93. doi: 10.1037/0022-0167.53.1.80
- Steiger, J. H. (2007). Understanding the limitations of global fit assessment in structural equation modeling. *Personal. Individ. Differ.* 42, 893–898. doi: 10.1016/j.paid.2006.09.017
- Streiner, D. L., Norman, G. R., and Cairney, J. (2024). Health measurement scales: A practical guide to their development and use. Oxford: Oxford University Press.
- Tabachnik, B. G., and Fidell, L. S. (2007). Using multivariate statistics. London: Pearson.
- Tavakol, M., and Wetzel, A. (2020). Factor analysis: a means for theory and instrument development in support of construct validity. *Int. J. Med. Educ.* 11, 245–247. doi: 10.5116/ijme.5f96.0f4a
- Teng, L. S., and Zhang, L. J. (2016). A questionnaire-based validation of multidimensional models of self-regulated learning strategies. *Mod. Lang. J.* 100, 674–701. doi: 10.1111/modl.12339
- Tinto, V. (2010). "From theory to action: exploring the institutional conditions for student retention" in *Higher education: Handbook of theory and research*. ed. J. C. Smart (Cham: Springer), 51–89.
- Weinstein, C., and Palmer, D. (2002). Learning and study strategies inventory (LASSI): User's manual. 2. Clearwater: H & H Publishing.
- Wong, J., Baars, M., Davis, D., Van Der Zee, T., Houben, G., and Paas, F. (2019). Supporting self-regulated learning in online learning environments and MOOCs: a systematic review. *Int. J. Hum. Comput. Int.* 35, 356–373. doi: 10.1080/10447318.2018.1543084
- Zimmerman, B. J. (2000). "Chapter 2- attaining self-regulation: a social cognitive perspective" in *Handbook of self-regulation*. eds. M. Boekaerts, P. R. Pintrich and M. Zeidner (New York, NY: Academic Press), 13–39.
- Zimmerman, B. (2013). From cognitive modeling to self-regulation: a social cognitive career path. *Educ. Psychol.* 48, 135–147. doi: 10.1080/00461520.2013.794676